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ORGANIZATIONAL MAINTENANCE IN THE SOVIET AIR FORCE

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PREFACE

This Memorandum reports the initial findings of a Project RAND study of Soviet Air Force logistics. Written by RAND consultant Andris Trapans, the Memorandum throws light on the practices and problems of organizational maintenance in the Soviet Air Force. It should interest logistics and operations planners in the United States Air Force, and students of Soviet military affairs in the government and the academic community.

SUMMARY

Since 1961 the Soviets have devoted considerable attention to improving base-level maintenance support of military aircraft. These efforts have shown, on one hand, a recognition of the need for keeping logistic support in pace with the increasing complexity of aircraft systems and equipment, on the other, the presence of a number of practical problems and areas of difficulty hampering the achievement of satisfactory solutions. This Memorandum surveys the institutional setting in which base-level maintenance is performed in the Soviet Air Force, notes the chief areas of apparent difficulty, and examines some of the solutions advanced. While a number of topics are touched upon, the main discussion concerns maintenance management. The time period considered is bracketed by the years 1960 and 1964.

Routine maintenance of Soviet tactical and fighter aviation is performed at air regiment level. Air regiments are the basic operational formations of the Soviet Air Force; with over 30 aircraft per regiment, they are considerably smaller than USAF wings. Organic maintenance elements provide logistic support of Soviet air regiments. Regimental maintenance elements are small formations; of this maintenance force, only relatively few people have advanced engineering or technical training. Air regiments are equipped to accomplish flight-line and periodic maintenance and a limited amount of minor repairs. As to regimental/base-level maintenance facilities, these reflect a preference for ruggedness and simplicity. Most maintenance is accomplished in the open, on hardstands or special servicing aprons. Hangar space is ordinarily not utilized for maintenance purposes, and usually there

are no docks. A particularly striking aspect of Soviet maintenance is that some of the tools and equipment regularly used are jerry-built. This approach apparently stems partly from necessity (state-produced equipment is not available), and partly from choice.

Maintenance organization and management reflect a preference for routinized assignments, centralized control, and centralized authority. Much maintenance work accomplished at regimental level seems to be actually directed by officers at higher echelons -- air armies and air divisions; for this reason, it appears, there usually are no maintenance staff functions at regiment level. Other peculiarities deserving mention are that until 1962 there seems to have been virtually no dispatching, and the services of maintenance specialists were often used inefficiently. In particular, the tendency to overcentralize authority has resulted in rigidities, misallocation of resources, and a number of conflicts between central and local objectives. Such tendencies have been aggravated by the attempts of regimental Communist Party organizations to inject themselves into maintenance management.

The institutional peculiarities of the system, while generating administrative pressures and misallocation of resources, have probably been present for some time and by themselves did not imperil the adequacy of regimental/base-level maintenance. They gain in significance, however, when viewed in the context of two other developments. Substantial indirect evidence indicates that in the early 1960's there developed quantitative and qualitative shortages of maintenance resources, in particular, of skilled labor and mobile specialized equipment. The reason for this, it seems, was the Soviet failure to adjust

labor-force training programs and to produce sufficient quantities of new maintenance equipment, warranted by advances in aircraft technology. It is possible this lag may be due to high-level policy decisions taken in the late 1950's.

In the meantime, regimental maintenance managers found themselves faced with labor and equipment bottlenecks, and, since new resources were not immediately forthcoming, attention had to focus on obtaining productivity increases with given resources. Soviet behavior since 1961 testifies that the search for ways and means of improving maintenance effectiveness had a sense of real urgency behind it. To alleviate pressures on regimental maintenance groups, the Soviets instituted a series of measures summarized by the slogan "increased utilization of internal reserves." Under this heading came: (1) high-pressure grass-roots campaigns to raise the skill levels of the maintenance force-in-being, (2) similar campaigns to raise labor mechanization levels by increasing local construction and innovation, and (3) reorganizations of regimental-level maintenance procedures. For a number of reasons the first two measures made only limited and patchy gains; in particular, they put additional pressure on local maintenance groups, and tended to further the introduction of non-standard equipment. Perhaps for these and similar reasons the Soviets, since late 1962, have concentrated on obtaining productivity increases through administrative reorganization. The education and innovation drives, while not abandoned, have been relegated to the background.

Recent organizational measures have included the introduction of dispatching and of centralized fueling and starting of aircraft.

Another development has been intensive experimentation with the so-called "flow-line" method of maintenance organization. "Flow-line" -- discussed in some detail in the Appendix -- involves rigid sequences of operations, detailed time standards for personnel, and exact positioning of men and equipment. It is suggested that the awkwardness of this approach makes it of doubtful value under conditions of uncertainty or combat.

Soviet efforts of "utilizing internal reserves" seem to have alleviated maintenance shortcomings but not eliminated them. The elimination of recent maintenance difficulties is to be sought in the institution of satisfactory labor-force training programs, the adequate flow of state-produced equipment, and devolution of administrative authority. Soviet pronouncements made in the military press during 1964 indicated that a number of moves were being made in this direction.

In the past, the ruggedness of base maintenance methods enabled the Soviet Air Force to deploy tactical aircraft quickly into austere bases. The growing complexity of their fighter aircraft may now put the methods in question and thereby slow down the deployment capability.

GLOSSARY

AVIAREMPRED (aviaremontnoe predpriiatie) - A shorthand term for aviation repair depot.

ATB (aviatsionno-tekhnicheskii batal'on) - Air Technical Battalion, the supply unit attached to air regiments.

IAS (Inzhenerno-aviatsionnaia sluzhba) - Engineering Aviation Service, responsible for all levels of maintenance in the Soviet Air Force.

PARM (Podvizhnaia aviatsionno-remontnaia masterskaia) - Literally a "mobile aviation repair shop," in this particular context it is a truck containing equipment and instruments.

POTOCHNYI METOD - "flow-line" method.

PUI (Punkt upravleniia inzhenera) - "Engineer's Control Point." The headquarters of the regimental Chief of Maintenance, usually a trailer.

SLUZHBA TYLA - Rear Services, in this context the supply service of the Soviet Air Force.

TECh (Tekhniko-ekspluatatsionnaia chast') - Periodic maintenance work center.

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I. INTRODUCTION

This Memorandum describes the institutional setting in which organizational maintenance is performed in the Soviet Air Force (SAF), indicates several areas of recent difficulty, and evaluates some Soviet attempts to eliminate such difficulties. Organizational maintenance has recently received close and critical attention from many Soviet military writers.

The Memorandum is based on open information, most of it scattered throughout the pages of the Soviet military press. The exploitation of such source materials is by no means easy. The Soviet desire for secrecy influences the content of open writings pertaining to military matters. There are a number of gaps and areas of uncertainty in the Soviet treatment of maintenance questions. Numerical data are seldom, if ever, given, and general surveys of maintenance structures are absent.

Still, a substantial amount of fragmentary information -- chiefly in the form of various reports, descriptions, and criticisms of low-level logistic support of Soviet military aviation -- has been released. It pertains chiefly to tactical fighter and bomber aircraft, as far as the information permits distinguishing the aircraft types referred to. Other materials include policy pronouncements issued by the higher authorities, the treatment of certain theoretical aspects of logistics, occasional manuals, and so forth. The amount and scope of information pertaining to military logistics has increased in recent years and there are indications that logistical support questions are being upgraded in Soviet military thought. Thus, it is possible to look forward

to additional information in this area. In the meantime, the source materials already available in effect form a window; in looking through it useful insights may be gained into the characteristics, strengths, and weaknesses of the system of Soviet military logistics.

II. MAINTENANCE ORGANIZATION AND PROCEDURES

Routine maintenance of military aircraft is accomplished by the using organization, and for this reason is called "organizational maintenance." In the Soviet Air Force, organizational maintenance is performed at air regiment level. An air regiment (aviatsionnyi polk) -- the approximate Soviet counterpart to the USAF wing -- is the smallest operational formation having a headquarters and a fixed aircraft and personnel establishment. In this sense it is the basic unit of the Soviet Air Force. The Soviet air regiment is usually assigned a single type of aircraft (there are over 30 aircraft per regiment, particular numbers varying according to type*). Each air regiment consists of several squadrons, usually three, and is ordinarily assigned to one airfield, although on occasion its squadrons may fly from two or more airfields. Above the air regiment stands the air division, and above the latter is the air army (its approximate U.S. counterpart is the numbered air force). The air army, it appears, is the highest echelon issuing direct orders to air regiments.

Logistic support to the Soviet Air Force is provided by two organizations. The so-called Aviation Engineering Service (IAS) is responsible for all levels of maintenance. Supply responsibility, on the other hand, rests with Rear Services. Both IAS and Rear Services sections are found on the staffs of major operational commands and form the two distinct logistic support elements of air regiments.

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*Handbook on the Soviet Army (Washington, D.C.: Department of the Army, 1958), p. 210.

The organization and responsibilities of regimental supply can be disposed of briefly. Supply support at this level is effected by Air Technical Battalions (ATB's). While Soviet military press reports do not reveal the exact size, organization, and responsibilities of this unit, they do give an approximate idea of ATB characteristics. Soviet sources usually mention ATB's and air regiments in a 1:1 ratio. Each ATB is commanded by a lieutenant colonel or major, which indicates that ATB personnel number a few hundred men. ATB's are divided into a number of functional companies and platoons (communications, transport, guard, etc.).

ATB's are responsible for guaranteeing base security and communications, providing POL and all kinds of supplies, keeping the airfield in operational condition, providing transport and quartermaster services, and so forth.* ATB responsibilities include servicing and maintenance of ground equipment, but not of aircraft. Thus, for illustration, ATB personnel provide technical aviation supplies and set up the stocks and equipment utilized in providing aircraft with fuel, air, and oxygen, but do not service aircraft.**

Maintenance of regimental aircraft is accomplished by personnel who form an organic part of the unit. A point to note is that there seems to be no civilian contracting at this level. As for the extent

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*For descriptions of ATB organization and responsibilities, see: A. A. Anpilov, "Tyl i polety," Vestnik Vozdushnogo Flota (hereafter referred to as VVF), No. 8, 1961, pp. 62-74; V. Maslennikov, "Potochnym metodom," Aviatsiia i Kosmonavtika (hereafter referred to as AiK), No. 8, 1962, pp. 60-64.

**N. Serebriakov, "Inzhener i predvaritel'naia podgotovka," AiK No. 4, 1962, p. 66.

and complexity of maintenance performed, this obviously varies with types of aircraft, airfield location and characteristics, maintenance resources available, and so forth. The following discussion treats the air regiment as the unit of Soviet tactical fighter or bomber aviation, assumes that there is one regiment per airfield, and that the airfield is neither a major base nor a graded earth or sod field. The time period under discussion is bracketed by the years 1960 and 1964. Exceptions are noted.

Maintenance in this context means the accomplishment of various inspection cycles and the repair of minor defects. The Soviets distinguish between the following types of maintenance performed:

(1) Preflight and Postflight Inspections (predpoletnaia podgotovka, predvaritel'naia podgotovka) - These appear to be primarily visual inspections of aircraft fuel, hydraulic and pneumatic systems, as well as the power plant, landing gear, and weapons. Postflight inspections are more extensive in scope.

(2) Special Inspections - The Soviets list a variety of "spot checks" (tselevye osmotry) and "complex inspections" (kompleksnye osmotry) made to detect wear and damage to equipment, connections, and assemblies. "Spot checks" are inspections of specific systems (e.g., fuel); "complex inspections" are more thorough inspections of a number of systems of a given aircraft. Both types of inspections are usually carried out on special days set aside for this purpose. The defects are noted, some being repaired immediately, others fixed during periodic maintenance.

(3) Periodic Maintenance (reglamentnye raboty) - This is maintenance performed for every 25, 50 and 100 flying hours,* and involves, where necessary, the teardown, inspection, and buildup of equipment, and the testing and calibration of certain parts. (As an aside, it

*Recently there seems to have been a tendency to eliminate 25-hour periodic inspections, compensating this by more thorough "spot checks."

is interesting to note that Soviet sources do not mention blackboxing.) During periodic maintenance minor defects are repaired, engine changes are effected, and the aircraft are listed AOCM.*

As the reader can see, most maintenance work falls into the "flightline" and "periodic" categories. While small machine shop facilities seem to be available to each air regiment, the Soviet formations apparently are not equipped to carry out medium repairs. When such repairs are necessary, regimental aircraft are flown, or shipped, to aviation repair depots (aviaremprédy).

A characteristic feature of SAF logistical support is that hangar space is generally not utilized for maintenance purposes, and inspection and maintenance docks are seldom present.** Preflight and postflight inspections, as well as spot checks, are carried out on hardstands or special servicing aprons. These flightline maintenance work areas seem to have few or no permanent installations and equipment storage facilities. Periodic maintenance is accomplished at what the Soviets loosely refer to as the "regimental TECh," or regimental technical-exploitation unit. This is simply a maintenance work center. The TECh consists of a hard-surfaced parking area on which one or several

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*There are numerous descriptions of the three types of maintenance accomplished. The following ones discuss matters in some detail: I. Zhuravlev, "Tselevoi osmotr v parkovyi den'," AiK, No. 6, 1962, pp. 71-75; G. Mikhailenko et al., "Kompleksnye osmotry aviatsionnoi tekhniki," AiK, No. 2, 1963, pp. 57-60; I. Zhuravlev and E. Khoroshilov, "Rabota TECh dvumia potokami," AiK, No. 6, 1963, pp. 65-74; Major General N. Zhuk, et al., "Potochnaia podgotovka samoletov k vyletu," AiK, No. 12, 1962, pp. 67-72.

**Soviet sources do mention the existence of docks (doki) at major air bases where medium and heavy repairs are accomplished.

buildings are located:

(1) A main one- or two-story brick building that houses work stands, tools, and equipment.

(2) A technical materials warehouse and/or a small stationary repair shop which provides machine shop facilities to the air regiment. Mobility is provided by at least one, but usually two or more, (PARM) mobile aviation repair shops. This imposing term is used to describe trucks containing equipment and instruments.

To perform their assigned tasks, regimental maintenance personnel have a limited quantity of rugged and relatively simple equipment, consisting mainly of various hand tools, work stands, power hoists, towing equipment, simple CAE (Communications, Armament, and Electronics) testing apparatus, and so forth. An important point to note is that part of the tools and equipment regularly used are built by regimental maintenance personnel themselves. This approach -- discussed in some detail later -- apparently stems partly from necessity (state-produced equipment is not forthcoming in sufficient quantities) and partly from choice (local construction permits utilization of services of local innovators).*

Two qualifications are in order. First, at major air bases maintenance facilities and equipment are more extensive, e.g., there are docks, and medium repairs are effected. On the other hand, if an air regiment is away from its home base and flies from a graded earth or sod field, its maintenance support facilities are truly spartan. In

*It might also be claimed that reliance on local construction permits simulation of actual combat conditions.

the case of one fighter regiment, for illustration, the regimental TECh was housed in tents and a collapsible shed, tools were packed in boxes and containers made by regimental maintenance personnel; a PARM (truck) and equipment installed on handmade carts, provided the mobility needed.* The situation just described underlincs the Soviet preference for ruggedness, simplicity, and avoidance of frills. The simplicity and ruggedness of maintenance facilities at other than major bases probably has enabled substantial numbers of Soviet tactical aircraft to appear quickly at austere air bases.

Turning now to the organization and management of maintenance, the regimental maintenance element appears to be approximately the size of its corresponding supply unit (the ATB) and is usually commanded by a lieutenant colonel or major. This man, referred to as the Senior Engineer (his full title is "regimental deputy commander for Aviation Engineering Service"), is the chief of maintenance. He is in sole charge of maintenance, in the sense that he is responsible only to the regimental C.O. (for operations) and to the IAS section at higher unit headquarters for technical and administrative matters, and must be obeyed by the officers and men under him. In practice, of course, the Senior Engineer has to reckon with the Communist Party, which constitutes an organized group within the regiment; besides its ordinary duties of political control and indoctrination since 1959, its bosses also deliberate on questions directly affecting maintenance management. Thus, the Senior Engineer is not only held responsible

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*The example refers to early 1962. V. D'iachuk et al., "TECh na polevom aerodrome," AiK, No. 5, 1962, pp. 59-66.

for the scheduling and execution of needed logistic tasks, but also for the level of military, political, and technical preparedness of the regiment's maintenance personnel.*

Maintenance organization reflects both "line" and "functional" approaches. The smallest unit is the work group, whose chief is the lowest-ranking administrator. Several work groups comprise a maintenance work center, supervised by a work center chief. This man -- a first lieutenant or captain having advanced engineering training (usually in the field of jet propulsion) -- is responsible for supervising the work processes and use of the equipment, and placing of workers at specific tasks. His direct superior is the Senior Engineer of the regiment. Thus, at first sight there appears to be a straight line of authority running up from the work group and work center chiefs to the Senior Engineer. Superimposed on this setup, however, is a functional organization, in which all maintenance personnel are divided into sections according to specialization. Each section is headed by an aviation engineering officer who has specialized training in armaments, radio and radiotechnical equipment, jet propulsion, or another particular field. These officers on occasion act in a staff and coordinating capacity, on others, are in charge of work centers or particular tasks. Recent changes in maintenance organization (discussed below) require careful scheduling of functional specialists, and have tended to increase the authority and importance of IAS officers with specialized training.

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*Ustav vnutrennei sluzhby Vooruzhennykh Sil Soiuza SSSR (Moscow: Voenizdat, 1962), pp. 41-43.

Above all this, the outside observer expects to find a sizable staff, consisting of several sectors, to aid the Senior Engineer in planning and coordinating maintenance work. Yet there apparently is no permanent staff. The Senior Engineer does have one or two deputies (zamestiteli), and a number of staff responsibilities are delegated to line officers, who meet daily (after working hours) to schedule coming work. In addition, a number of auxiliary and advisory commissions, in which the regimental Communist Party organization plays a leading role, are used as a sort of ersatz staff function.* (The Party thus injects itself into logistics management.) Yet all these efforts are clearly insufficient for the task at hand, and the real answer seems to be simply that IAS staff sections are found at air division and higher levels -- an indication to what degree administration of maintenance is centralized in the Soviet Air Force.

Maintenance work is scheduled on the basis of: (1) a monthly flight plan, fixing the extent of flying activity for the coming month; (2) log books of aircraft and engines, containing records of maintenance data, as well as records of air and ground operational time; and (3) a number of "how to" handbooks and manuals prepared by scientific research organizations and consisting of illustrated descriptions of aircraft equipment and enumerations of the tasks of various specialists.** With these documents and his own experience to guide him,

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*See Sec. III.

**M. Riakovskii, "Inzhener i podgotovka aviatsionnoi tekhniki," AiK, No. 9, 1963, p. 53; VVF, No. 6, 1961, pp. 79-80; Major General N. Schepankov," Ne formal'no, a tvorcheski," AiK, No. 1, 1964, pp. 56-60.

the Senior Engineer then breaks the monthly maintenance plan down into weekly and daily plans. As to performance standards and targets, numerous references to accident-free aircraft performance indicate that this is the chief measure of performance of maintenance personnel over given periods of time; quality, rather than speed of work, seems to count most. Another characteristic feature of SAF maintenance is the presence of time standards ("norms") for given operations and entire sequences of operations. Time standards were occasionally mentioned as early as 1958, but seem to have been broadly introduced during 1962/63, and therefore are discussed below.*

Cost reduction is another index of achievement. It is understood, for example, that one should economize on fuels, spare parts, and other inputs.** Yet in practice, military considerations (preparedness) outweigh cost considerations. Thus, it is not unusual to see Soviet spokesmen first call for economies, and then emphasize the decisive significance of military preparedness.*** In practice, therefore, the occasional economy drives and exhortations seem to mean little.

Turning back to the regimental maintenance organization, the flow of work is as follows: Flightline maintenance (preflight and post-flight inspections, spot checks) is performed by personnel attached

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*See Appendix.

**A detailed Soviet statement on the question of economizing on inputs is provided by S. Golota, "Rezhim ekonomii -- neprelozhnyi zakon kommunisticheskogo khoziaistvovaniia," Kommunist Vooruzhennykh Sil, No. 18 (September), 1962, pp. 9-17.

***For a particularly striking juxtaposition of these two ideas, see: Lieutenant General V. N. Koblikov, "Da, nasha rabota - delo tvorcheskoe," VVF, No. 5, 1961, p. 55.

to each squadron; periodic maintenance is accomplished at the "regimental TECh" mentioned previously. Thus, within the regiment the flow of work is between squadron work centers and the "regimental TECh." For major repairs and overhauls, the aircraft are flown, or shipped, to military aviation repair depots. These arrangements point to one more peculiarity of the Soviet approach -- namely, to the absence of specific maintenance functions (e.g., CAE maintenance, munitions maintenance, and so forth) and serve as yet another indication of the relatively small size of the regimental maintenance element.

Nominally the seven-hour workday, six days per week is standard. Since 1962, two-shift maintenance work has been widely introduced, with consecutive or overlapping shifts.

III. PROBLEM AREAS OF ORGANIZATIONAL MAINTENANCE

Having surveyed the institutional setting in which maintenance is performed, the discussion now turns to certain operational aspects and problem areas of maintenance management. At regimental/base level several areas of weakness and difficulty seem to exist, some stemming from scarcity of maintenance resources, others generated by the institutional peculiarities of the system itself. And this is not surprising; no logistical system is perfect, and constant tinkering and attempts to improve matters are the rule rather than the exception. What should be emphasized, however, is that the degree of stresses and strains appears to have significantly increased during the early 1960's. Between 1961 and 1964, questions of base-level maintenance support attracted the critical attention of many Soviet military writers, and an urgent search for means of improving aircraft maintenance was under way.

Three broad interrelated areas of institutional-practical difficulty could be distinguished. A few things will be said about each of these.

The first problem concerned mechanization, or rather the lack of it, in maintenance work. During 1961 it was reported, to cite a few examples, that there were cases when six men spent four hours to take off the wheels of one aircraft, doing all the work by hand; that fueling of aircraft was only partly mechanized; that flightline maintenance personnel had to dismantle equipment and lug it to the regimental TECh for checking, since only this work center had the equipment needed; indeed, that CAE and other equipment had to be laboriously

dismantled, checked, and installed again -- not by choice but by necessity, since there simply was no portable CAE testing apparatus.* Officers from several air regiments reported that industry provided only a part of the testing installations and work stands; maintenance personnel built the rest themselves.** These examples, while perhaps extreme, illustrate the tenor of Soviet complaints during the 1959-1962 period. What seemed to be lacking was power-driven mobile equipment in general, and portable instruments for testing and calibration of CAE systems in particular; accordingly, the efforts of local inventors and innovators were focused chiefly on these areas. A more recent (June 1964) pronouncement concerning ground equipment questions came from Colonel General F. P. Polynin, Chief of Rear Services of the Soviet Air Force. Polynin, writing in the armed forces newspaper Red Star, noted that lately progress had been made in supplying state-manufactured equipment to operational units, but added that further improvements were still needed.***

The equipment shortage problems were linked to, and compounded by, a shortage of skilled manpower. The context of Soviet sources examined indicates that there was not enough skilled labor; moreover,

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*N. I. Khirnyi, "Mekhanizatsiia na smenu ruchnomu trudu," VVF, No. 3, 1961, pp. 66-68; Iu. S. Maslovskii, "Kak reshit' spornye voprosy?" VVF, No. 2, 1961, pp. 61-62; L. I. Selianinov, M. F. Rebrov, "Novoe vkhodit v zhizn'," VVF, No. 10, 1961, pp. 30-31.

**A. E. Gusel'nikov, "Tvorchestvo - ne radi tvorchestva, VVF, No. 2, 1961, p. 59; N. I. Khirnyi, VVF, No. 3, 1961, pp. 66-68.

***Red Star, June 14, 1964.

what maintenance force there was, had, in part, insufficient qualifications to meet the tasks demanded of it. Only a relative handful of officers -- engineers and technicians first class -- had advanced technical training. There were also a number of mechanics among the enlisted men. A large part of regimental maintenance personnel, however, consisted of so-called "specialists" and "junior specialists" -- two misnomers, since these were really mechanics' aides with very limited qualifications. One IAS major in May of 1963 referred to the training of mechanics as follows:

> The time taken now to train and send out mechanics is extremely unsatisfactory. It is clearly evident that a person who has just come from tending a machine or combine or is just out of school cannot, in the space of 6-8 months, properly learn the construction, functioning, and regulations for servicing the most complicated complex of systems in today's aircraft and its power plant . . . It is impossible to acquire the necessary skills during this or even a somewhat longer period of time.*

The training given aviation mechanics was said to be too broad and superficial, necessitating on-the-job retraining in more narrow and specialized tasks.** For engineers, too, broad versus narrow training has been an issue that has been debated for some time in the Soviet military press. Running through the complaints about manpower training was an undercurrent of dissatisfaction with the role of military research organizations and educational institutions. One IAS lieutenant colonel in July 1963 stated:

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*V. Ivanov, "Aviatsionnomu mekhaniku - uzkuiu spetsializatsiiu," AiK, No. 5, 1963, p. 85.

**Ibid.

> Life itself demands the revision of established practices for training of IAS personnel, its further improvement. We won't mention the organizational forms of technical training. The point is its substance. The units are awaiting help from scientific institutions, academies, schools. The first step in this direction has been the issue of an aviation technicians' handbook. But this is little. The units need help.*

One result of this state of affairs seems to have been that new maintenance personnel, after assignment to permanent units, had to spend much time in training on operational aircraft. The result of this, in turn, was increased pressure and work loads on the available, technically qualified personnel.

Equipment and labor scarcities, however, accounted for only a part of regimental maintenance difficulties. The institutional peculiarities of the system itself tend to generate administrative pressures and misallocation of resources. Take the organization of labor, for example. Until 1962 there was little or no dispatching. Maintenance specialists were not concentrated in task forces, but were scattered among the various work centers. Further, recall that the regimental maintenance organization had only a small de facto staff. This in effect meant that the Senior Engineer, his subordinate line officers, and the few Party-dominated auxiliary committees had to concern themselves with central workload control, maintenance standardization, quality control, and other questions.

Perhaps recognizing the difficulties inherent in such arrangements, the Soviets in 1960-1962 attempted to alleviate some of the

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*A. Paramonov, "Aviatsionnyi tekhnik," AiK, No. 7, 1963, p. 84.

pressure on maintenance managers by building in a series of checks and balances -- a sort of automatic quality control -- in the regimental maintenance organization. In short, the personnel of a given work center were required to inspect the work performed by another. In the words of Lieutenant General V. N. Koblikov:

> [Both] groups, as it were, mutually control and even inspect each other . . . The regimental TECh performs periodic maintenance on aircraft, and therefore has to control how these are utilized and serviced between periodic work . . . The [squadron work centers] in charge of maintenance between periodic work, are interested in the work of TECh personnel. And if such mutual control results in certain pretensions, that is good, and such contradictions are useful. Multi-step control of aviation technique not only increases flight safety, but also makes aircraft crews aware of the presence of such a safety factor.*

It should be remembered, however, that there existed a tight manpower and equipment situation, and that in order to effect such mutual quality control, the responsibilities of particular work centers had to be outlined in detail. In such a situation it is likely that a given maintenance group would see a job in terms of its component parts, i.e., if a group was judged by the successful fulfillment of "its" responsibilities, it was prone to ignore the correction of aircraft defects that lay within the province of "others." Even more -- since there always would be some marginal tasks, each group would seem to be tempted to "get away with" as much as it could. A particular difficulty here, it was said, lay in the centrifugal tendencies of each maintenance group. In practice the system of quality control

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*Lieutenant General V. N. Koblikov, VVF, No. 5, 1961, p. 53.

through mutual inspection tended to result in prolonged bickering, and aircraft occasionally flew with known defects.* After 1962, mentions of mutual control disappeared from the pages of the Soviet military press, suggesting that this approach had been modified or abandoned.

What comes through clearly from Soviet materials is the great pressure that regimental maintenance officers are subject to. The military and Party authorities have issued numerous statements on the importance of the Senior Engineer. He is the executant, the man who is supposed to best know the resources at his disposal and who is supposed to plan their rational allocation in a fluid situation. One would therefore expect that the Senior Engineer and his subordinates have considerable latitude for independent decision-making. Not so. The IAS sections at air army and air division headquarters not only regularly inspect the maintenance work accomplished by regimental personnel, but subject the latter to streams of directives dealing with every phase of maintenance work. Thus, the Soviet approach emphasizes centralized control and centralized authority. The following example gives an idea of the negative by-products of this approach:

> Let us take, for illustration, two IAS matters. The first concerns a file of telegrams, the second -- directives which pertain to the Aviation Engineering Service. What a variety of telegrams could be found there! The number [of telegrams received by regimental maintenance] per year is written with three digits. "Report . . ." "Send information about . . ." "Check on . . ." "Urgently report for repairs . . .", with such words begin most of the telegrams.

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*Maslovskii, loc. cit.

> Let us open the second file. Our engineers had a difficult time of it in October. On Saturday the 15th two documents arrived. One demanded that a report be submitted by the 18th. "In your report discuss the following questions in detail," began the document. Then followed a list of questions and subquestions in which the total number of items reached twenty-one. In order to write the report it was necessary to call together the TECh chief and regimental and squadron engineers. But even by the joint efforts of all six of them it was physically impossible to answer all the questions by Monday. But then the higher echelon understood that the time limit was unrealistic. The unit received a new telegram: Submit report by the 25th. The second document order to "reconsider by November 5th and send your evaluation about . . .", and again there followed an enumeration of items. The situation was actually worse, for already on October 11th the unit had been ordered to . . . "send concrete proposals" in which the engineering-technical personnel had to comment on matters concerning "the contents and structure of . . ." Further followed nine questions which required detailed answers.*

To be sure, such bureaucratic aberrations did not occur every day. Still, it seems correct to say that maintenance officers were subject to intense paperwork pressure. Early in 1964 a group of Soviet maintenance specialists estimated that squadron level maintenance officers spent 20 to 25 per cent of their duty time on paperwork; for regimental level maintenance officers the corresponding figure was 40 to 50 per cent; for above regiment levels, 70 to 75 per cent. The percentages were said to be increasing lately.** To place these figures in proper perspective it should be recalled that most squadron and regiment officers were not staff, but line doubling as staff.

Indeed, Soviet materials suggest that the entire system of base maintenance management primarily reflects the administrative objectives

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*N. G. Kon'kov et al., "V poiskakh novogo," VVF, No. 1, 1961, p. 68.

**Red Star, May 31 and July 3, 1964.

of controlling agencies rather than the needs of performing organizations. Yet overcentralization and failure to delegate authority involves costs -- the higher echelons cannot fully know local resources and needs of the moment; communication involves distance and time and makes for bureaucratic delay, besides putting paperwork pressure on the communicants. And on occasion central and local objectives may be conflicting. The system of mutual inspection and control that the higher authorities endorsed, illustrates such a conflict. Another example concerns the several kinds of dokumentatsiia (log books and manuals) issued to regimental maintenance personnel. These, although satisfactory from the viewpoint of higher authorities, have been subject to complaints from Soviet field officers. Standard dokumentatsiia, it was said, were of little use in planning future workloads and establishing patterns of equipment breakdowns. "It is no secret," wrote a Soviet line officer, "that in the units each engineer, besides a standard log book, has, as a rule, a log book worked out by himself, which contains data on aircraft and engine performance, periodic work, and so forth."*

To summarize, administrative pressures and the consequent misallocation of resources stemmed at least in part from overcentralization of authority and the poor division of labor within air regiments; the Soviet system of maintenance management had certain built-in weaknesses and rigidities. These problems were not brand new; they had probably been present for some time. It was the lack of certain

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*VVF, No. 6, 1961, pp. 79-80; M. Riakovskii, AiK, No. 9, 1963, p. 56.

maintenance resources -- in particular, it seems, of skilled labor and specialized equipment, which during the early 1960's compounded the problems. Soviet pronouncements and activities between 1961 and 1964 suggest that some kind of base-level "maintenance gap" had emerged, a gap which the Soviets have recently attempted to close.

The possible causes of such a gap deserve mention. The late 1950's and early 1960's,a period of rapid technological advances in military aviation, saw the introduction of relatively sophisticated supersonic aircraft in SAF operational formations; in particular, aircraft CAE systems were being improved and modified. This in turn meant that the volume and complexity of maintenance work also increased,* necessitating both qualitative and quantitative changes in maintenance resources, namely (a) adjustments in labor force training programs, and (b) a flow of new state-produced maintenance equipment. There are indications that such adjustments were being effected during 1963-64; yet they should have come several years earlier. A number of technical, fiscal, and political problems seem to have contributed to the time lag. During the late 1950's the Soviet Air Force, in terms of manpower, was significantly reduced, and a part of its specialists were transferred to civilian employment (Aeroflot, helicopters) and to the Soviet missile forces. This was also a time of keen competition for resources between the SAF and the Strategic Missile

*In 1962 and 1963 there were a number of mentions to the effect that two-shift maintenance work had been recently introduced: N. Serebriakov, AiK, No. 4, 1962, p. 68; V. Maslennikov, AiK, No. 8, 1962, p. 56; Major General N. Zhuk, et al., AiK, No. 12, 1962, p. 67.

Forces, one in which the SAF probably came off second best. And finally, since about 1957 the role of aircraft in Soviet strategic doctrine has experienced ups and downs.* Policy decisions, a general climate of uncertainty, the channeling of resources into alternative employments, and bureaucratic inertia thus seem to have been the main causes of recent base-level maintenance difficulties.

The evolving complexity of Soviet fighter aircraft may by now put in question some of the primitive base maintenance methods and equipments. To the extent that this is the case, the SAF may face greater difficulties than heretofore in quickly deploying tactical aircraft into bare base facilities. Continuing brief mentions of special procedures to be used in maintenance of aircraft flying from unimproved airfields indicate, however, that the Soviets wish to retain rapid redeployment capability.

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*V. D. Sokolovskii, ed., Soviet Military Strategy, a translation by The RAND Corporation, R-416-PR, April 1963, analysis and annotation by H. Dinerstein, L. Gouré, T. Wolfe, U.S. ed., Note A, pp. 351-353; Leon Gouré, "Notes on the Second Edition of Marshal V. D. Sokolovskii's 'Military Strategy,'" RM-3972-PR, February 1964, pp. 83-86.

IV. RECENT MEASURES TO IMPROVE MAINTENANCE

The preceding pages contained a brief account of the chief problem areas of Soviet regimental/base-level maintenance. Some of the solutions advanced are considered next. As already mentioned, there seem to have been certain obstacles to the rapid elimination of maintenance difficulties. The first was the time element -- the production of new factory-made equipment took time; so did the effecting of new manpower training programs. From the standpoint of regimental maintenance managers, then, attention had to be focused on obtaining productivity increases with given resources. The second point concerns the preferences of higher authorities. Certain policy evaluations were probably instrumental in causing the difficulties in the first place. And while it seems to have been generally agreed that regimental logistic support groups should function as efficiently as possible, the Soviets apparently wanted to retain the existing system of centralized control and authority. This did, of course, leave open the question of administrative changes within air regiments.

The chief measures actually taken may be summarized by the slogan "increased utilization of internal reserves." Under this heading came (a) high-pressure grass roots campaigns to raise the skill levels of the maintenance force in being, (b) similar campaigns to raise labor mechanization levels by increasing local construction and innovation, and (c) changes in the division of labor within air regiments. It is not possible to tell how much local initiative and how much administrative direction was involved. Local tinkering and experimentation

has certainly been channeled ("whipped along" would be a more descriptive term) by high-pressure campaigns from above.

Within air regiments both the education and innovation drives were effected through a number of newly created auxiliary and advisory committees. The first to be established (1960) were technical councils. These were followed, in short order, by councils working on labor methods, by committees on innovation, by education and military-technical committees, and so forth. At the local level "leading experience" was spread by lecture series and base conferences of innovators. Other means included utilization of the armed forces' communications media, conferences, and exhibits. A key role in generating these drives was played by regimental Communist Party organizations. Local Party groups already in 1959 were given rights to deliberate on questions of logistics management and were expected to act in the general capacity of "bottleneck eliminators."* The education and innovation drives were both linked to "socialist competitions," in which given units and/or individuals pledged to achieve a certain degree of skills, mechanization of labor, or improvement in work indices. Incentives were provided by having financial rewards, recognition, and advancement partly depend on the outcome of such competitions.

To briefly enumerate the main measures taken to retrain the labor force in being, various programs of study were set up, ranging from on-base lectures to university correspondence and extension courses.

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*For a discussion of the growing role of the CPSU in Soviet armed forces' management, see G. Shandala, "O vozrastaiuschei roli KPSS v rukovodstve Vooruzhennymi Silami," Kommunist Vooruzhennykh Sil, No. 8, April 1962, pp. 9-18.

On the whole, the Soviets tended to emphasize supplemental training in more specialized areas of maintenance work. Another development was the emphasis on training pilots and aircraft crews to familiarize themselves with the maintenance characteristics of their planes; this was said to permit their utilization as auxiliary maintenance personnel and thus provided a manpower cushion to fall back on.* There are indications that the system of advanced technical education for aviation officers is being reorganized; thus, for example, a program of training "pilot-engineers" has been instituted, with the first such graduates joining operational fighter units in late 1963.**

Simultaneously, a concentrated effort to stimulate the activities of local inventors and innovators has been going on. Local efforts were focused chiefly on manufacturing CAE testing aids and on building mobile equipment. The latter category included a whole range of articles from simple suitcases and boxes for the transportation and storage of tools, to intercom systems and power-driven apparatus. Certain types of equipment have been built by most air regiments. Take, for illustration, the PUI (Engineer's Control Point). This is a small trailer which serves as the mobile headquarters for the regimental chief of maintenance; here the Senior Engineer writes reports, issues directives (an intercom system links the PUI to work centers) and receives subordinates. The desirability of having PUI's was first

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*A. R. Slivka and M. V. Corislavets, "Parkovyi den'; a chto delaet letnyi sostav?" VVF, No. 6, 1961, pp. 52-57; I. Vasil'ev, S. Fedin, "V dve smeny," AiK, No. 3, 1963, p. 57.

**Red Star, December 22, 1963.

recognized in 1960,* and by 1963 they were reported to be "present in all units."** Most PUI's, as well as the intercom systems, seem to have been jerry-built.

What of the efficacy of the education and innovation drives? Soviet press reports describe some remarkable achievements in these areas. There is little doubt that numerous local innovations and other fruits of practical experience became available to state production and research agencies; from the standpoint of the higher authorities, then, both drives seem to have resulted in tangible and concrete gains. From the standpoint of local maintenance groups it appears that mechanization and manpower skill levels were somewhat improved, but at disproportionate costs. There clearly was an increase in the activity levels of local logistic support groups, but such efforts by themselves were insufficient to solve the problems at hand; they were palliatives rather than cures, and their institution tended to further aggravate a number of existing problems.

To begin with, there was little uniformity in the scope and intensity of local efforts. The number, names, and responsibilities of the various sections and committees in charge of education and innovation varied from regiment to regiment; the drives themselves had a jerky "campaign" character, targeting achievement levels and concentrating on fulfilling obligations by certain dates, e.g., Party congresses and plenums, Aviation days, October revolution anniversaries,

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*Sovetskaia Aviatsiia, February 23, 1960.

**G. Mikhailenko et al., "Kompleksnye osmotry aviatsionnoi tekhniki," AiK, No. 2, 1963, pp. 58-59.

and so forth. Within each regiment there usually were several parallel agencies concerned with the same tasks. In short, there was a great froth of activity, much of which was empty.*

One result of this was the availability of wide possibilities for dissimulation. It was not unusual to see the same improvements pledged several times over and thus "multiplying themselves." Moreover, the entire effort appreciably increased the workloads of the Senior Engineer and his subordinate officers, and thus put additional pressure on the undermanned maintenance groups. Occasionally the resentment of Soviet officers was expressed in no uncertain terms; thus, one maintenance officer, commenting on the feasibility of establishing one more section for the study and dissemination of foremost experience, wrote as follows:

> Isn't it time to revise and put an end of such great numbers of organizations in the units, such as military-scientific, technical, and methodological councils, committees on innovation and invention, all the subcommittees and sections -- which, to be blunt, have the same task -- to study, work out, and introduce foremost experience and better forms and methods in training the armed forces?
>
> Isn't it true that, as a rule, each committee and council of the [air] regiment is composed of and headed by the very same people? [Yet] each council and committee has its own plan of work and carries out sessions and meetings.**

Lieutenant General P. Kutakhov, writing about the negative features of the education and innovation drives, was even more explicit:

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*A discussion of the behavioral features of the drives lies outside the scope of this Memorandum. Suffice it to say that the chief fault here, as in similar drives in the Soviet civilian economy, lay with the modus operandi of local Party bosses.

**G. Mikhailenko, "Novye formy," AiK, No. 11, 1962, p. 67.

> You see, our every good beginning at some time takes a turn, somehow the rational substance evaporates from it, and only the formal shell remains. This results from the fact that we make a living and creative task to fit a kind of Procrustean bed and regulate everything without exception.*

Further, it should be pointed out that there were strict limits to what could be accomplished with the tools, time, and money available. A part -- if not all -- of the money used in financing local construction came from regimental budgets, hence there always was a budget constraint. And perhaps the chief negative feature of such drives, indeed, of grass roots activity in general, was that achievements were apt to be patchy, accenting variances in mechanization and manpower skill levels between regiments, introducing non-standard equipment, and thus sharpening variations in maintenance effectiveness in the Soviet Air Force.

In 1962, the Soviet search for new ways and means of "utilizing internal reserves" turned to the area of maintenance organization. Local education and innovation efforts thus came to play a secondary, though continuing, role.

During 1962 and 1963 considerable publicity was given to a number of new methods of resource organization. Centralized starting and fueling of aircraft was reportedly being introduced, and the principle of a central workload control and dispatching was hailed (late 1962) as a great discovery.** (As an aside, it is interesting to note that the Soviets may be studying USAF maintenance procedures in the hopes

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*P. Kutakhov, L. Fil'chenko, "Zhivoi rodnik tvorchestva," AiK, No. 11, 1962, p. 56.

**V. Liberman, "Rezervy? Vot oni!," AiK, No. 10, 1962, pp. 62-65.

of finding answers to their own problems. An unusually detailed and sober account of USAF wing/base-level maintenance organization and procedures appeared in the December 1962 issue of the SAF monthly Aviation and Cosmonautics.)

Recently a number of Soviet aviation engineering officers have claimed that an organizational solution to the most urgent maintenance problems had been found. This was the so-called "flow-line" method of resource organization. Essentially "flow-line" requires strict sequences of operations, specialist dispatch, and detailed time standards ("norms") for each operation and process. The problem then consists of positioning personnel and equipment and of assuring a rapid and rhythmic flow of aircraft (or, if the aircraft is stationary, of personnel and equipment) between such positions. A more detailed description of "flow-line" is found in the Appendix. The use of "flow-line" was first mentioned in the Soviet military press in late 1962, and the approach was almost immediately singled out for approval by two major generals of the SAF Engineering Technical Service, N. Zhuk and D. Vas'iukov.* As of early 1964, matters were apparently still in a stage of intensive experimentation, with several variants of the method being tried out. From the rather sparse accounts of the approach published, it can be gathered that early enthusiasm has become tinged with caution. On one hand, it has been stressed that "flow-line" permits more efficient utilization of available resources, particularly of skilled manpower; thus, idle time was said to have been reduced

*Major General N. Zhuk et al., AiK, No. 12, 1962, pp. 67-72; Major General D. Vas'iukov, N. Dremov, "U nas est' rezervy!," Aik, No. 1, 1963, pp. 61-64.

and the ability of maintenance to keep pace with increased flying hour outputs significantly improved. One IAS lieutenant colonel wrote that this approach was characterized by "the complete absence of any kind of [additional] material expenditures," requiring neither modifications of equipment nor increases in maintenance manpower.* If this be the case, then such "utilization of internal reserves" is clearly acceptable to the higher authorities.**

The same author noted, however, that the method "up to now [September 1963] was still poorly utilized" in operational units.*** Indeed, it is not difficult to see why this should be so. The establishment of fixed sequences of operations and of detailed time standards

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*M. Raikovskii, Aik, No. 9, 1963, p. 52.

**From the standpoint of organization theory this approach has some interesting results. First, the process itself exerts the major constraints on workers (i.e., indicates what job they are to do next, what materials and tools are to be used, the pace at which work must be done, etc.) and thus lessens the need for supervision and control. Next, the process tends to reverse the flow of demands (I am assuming that previously demands flowed downward in the hierarchy, i.e., orders were received from the level above and transmitted to the level below). Now, with the process itself as an "organizer," the pattern of interaction is more likely to be one in which the worker requests the foreman's help (whether he needs advice or supplies); the foreman seeking services and instructions, initiates most of the interaction with his superiors and staff officials. The foreman's chief task is transformed from directing and checking on subordinates to helping them and being their trouble-shooter. Thus, the new system would seem to alleviate the pressure on managerial resources. Yet this is clearly an insufficient yardstick to use. The question which should be asked is whether "flow-line" is to be preferred from the standpoint of general maintenance effectiveness? It is suggested that the approach is brittle and cumbersome and may lead to adverse effects under conditions of uncertainty or combat (see below). This problem once more indicates a conflict between local and general objectives.

***Ibid.

is simple under conditions of certainty. Much of maintenance, however, is characterized by randomness of defects. Further, such an approach necessarily requires identification of the number of jobs, and this in practice is a matter of considerable difficulty.* In short, it is not possible to establish uniform time standards and sequences of operations throughout the SAF which are operationally meaningful. Standards and sequences would have to vary from unit to unit (Soviet sources indicate that this, in fact, is the case), and even here sizable parameter swings require cumbersome recalculations. All in all, while "flow-line" may have certain advantages in servicing aircraft for take-off, it is difficult to see its advantages elsewhere, particularly under combat conditions.

Soviet measures to improve base-level maintenance through "increased utilization of internal reserves" thus may be said to have achieved limited results at disproportionate costs in the time and effort of regimental maintenance personnel. Most of the actual gains made probably resulted from reducing the misallocation of resources, in particular, from introduction of dispatching and the concentration of specialists in task forces. All of these are essentially short-run, stopgap measures. The elimination of recent Soviet maintenance difficulties depends on long-run policy changes: institution of satisfactory labor force training programs, the adequate flow of new, state-produced equipment, and devolution of administrative authority. Soviet pronouncements in the military press during 1964 indicated that a number of moves were being made in this direction.

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*I am indebted to Chauncey F. Bell for this observation.

Appendix

THE "FLOW-LINE" METHOD IN SOVIET FIGHTER MAINTENANCE

The following is a brief sketch of the salient features of the "flow-line" method in Soviet fighter maintenance. It draws on a composite of Soviet sources and hence should be taken as an outline of a general approach rather than the accurate description of maintenance methods used in any single operational fighter unit.

FLIGHTLINE MAINTENANCE

With the "flow-line" method, the sequence of operations in servicing and preflight maintenance is thought of in terms of a single process, a cycle. Labor, equipment, and the individual operations to be performed are assumed fixed. The problem then consists of positioning personnel and equipment and of assuring a rapid and rhythmic flow of aircraft between such positions. The key to this is time norms for personnel.

Maintenance staffs begin by making up so-called technological charts for servicing single aircraft. First, the number of separate operations on the aircraft is established; next, the length of each operation is timed (the observations are done by stopwatch and the results averaged out); finally, trial-and-error adjustments show which particular sequence of operations minimizes time expenditures. The technological chart then is modified to take into account the servicing of a group of aircraft.

The technique for working out plan charts is similar. The plan chart determines the time each technician and mechanic spends per

aircraft, again making appropriate adjustments for groups of aircraft. The preferred sequence of operations and the time norms (in minutes) allowed for each operation are then fixed by order of the Chief of Maintenance and become law for the personnel concerned. Actually, not one but two to three versions are worked out; each one applies to a basic combat mission of the aircraft. All charts are modified as needed.

Thus, in the words of one Soviet aviation engineering officer,

> Every specialist, when working according to the plan chart, always carries out the same operations in the same strictly defined and always identical sequence, this having been predetermined. Also, when working on the aircraft he always uses the same devices and tools in a strictly predetermined and always identical sequence.*

To illustrate, consider the servicing of multiple fighter sorties. Maintenance facilities and personnel are stationed in three "technical positions" (TP's).

The fighter lands and taxies to TP I (residual burning check, inspection of landing elements and weapons); then is towed to TP II (servicing with air and fuel, inspection of aircraft and engine); then is towed to TP III (loading with ammunition, starting engine). Each worker has a plan chart; men are directed by position chiefs who in turn report to the shift chief (flights, and hence their support, are organized in two consecutive shifts). If there are malfunctions that cannot be eliminated in the time allotted to each TP, the aircraft is towed off and one of several standby aircraft is used instead.

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*M. Riakovskii, AiK, No. 9, 1963, p. 57.

PERIODIC INSPECTIONS

The "flow-line" method has also been introduced in 50- and 100-hour periodic inspections. These are carried out in regimental work centers -- hard-surfaced parking areas with a small building that houses "laboratories" (immobile testing apparatus and work stands). Hangar space and docks usually are not available.

Here, too, time norms have been established. Again, the number of individual operations to be performed is assumed to be fixed (sic!). Having established the time of each operation and the time for the sum of operations on one aircraft, the Soviet maintenance staffs extend the results to several aircraft, once more making stopwatch observations and trial-and-error adjustments. This time, however, the cycle of operations for each aircraft includes a safety margin of time. The chief determinant in establishing maintenance capability is the man-hour availability of the most skilled specialists, this being the scarcest resource. As for unpredicted malfunctions and parts failures, the Soviets assume that some of these would be eliminated during the reserve time. Major malfunctions are eliminated outside the "flow-line" by a group of reserve specialists who replace defective assemblies, units, and apparatus; these draw on a special "replacement reserve" of tools and spare parts.

Time norms for maintenance personnel are indicated on so-called technological cards. At the beginning of the working day each man is given one such card indicating: (a) the number and sequence of operations he has to perform and the time norm for each, (b) relevant technical specifications and observations. There are two basic cards,

one for 50-hour and the other for 100-hour inspections; if the particular job requires two men, they are given joint cards. Personnel inform the dispatcher about the completion of each operation. Thus, it is the dispatcher who watches the rhythm of work and informs the respective work group chiefs about time lags and bottlenecks.

Equipment and personnel are positioned as follows: First a number of functional work stations are deployed in the parking area, e.g., one for radio and radiotechnical equipment, another for armaments, a third for engine, and so forth. Each consists of one or several trucks and trailers housing tools and equipment, and is stocked with spare parts and materials sufficient for one day's work. A work station thus is the "home base" of technicians and mechanics of a given specialty.

Several aircraft, ordinarily two to four, are parked between the work stations. Each aircraft is divided into a fixed number of separate sectors, e.g., nose and gun compartment; cockpit; wings; landing gear; fuselage; engine; aircraft systems. The number of such sectors depends on the type of periodic maintenance accomplished. The aircraft as objects of labor remain immobile. The flow in the "flow-line" is provided by personnel who pass from aircraft to aircraft on the basis of their technological cards. Their work in a given sector of the aircraft is controlled by a sector chief. Equipment which has to be dismounted and disassembled is checked in "laboratories" of the building.

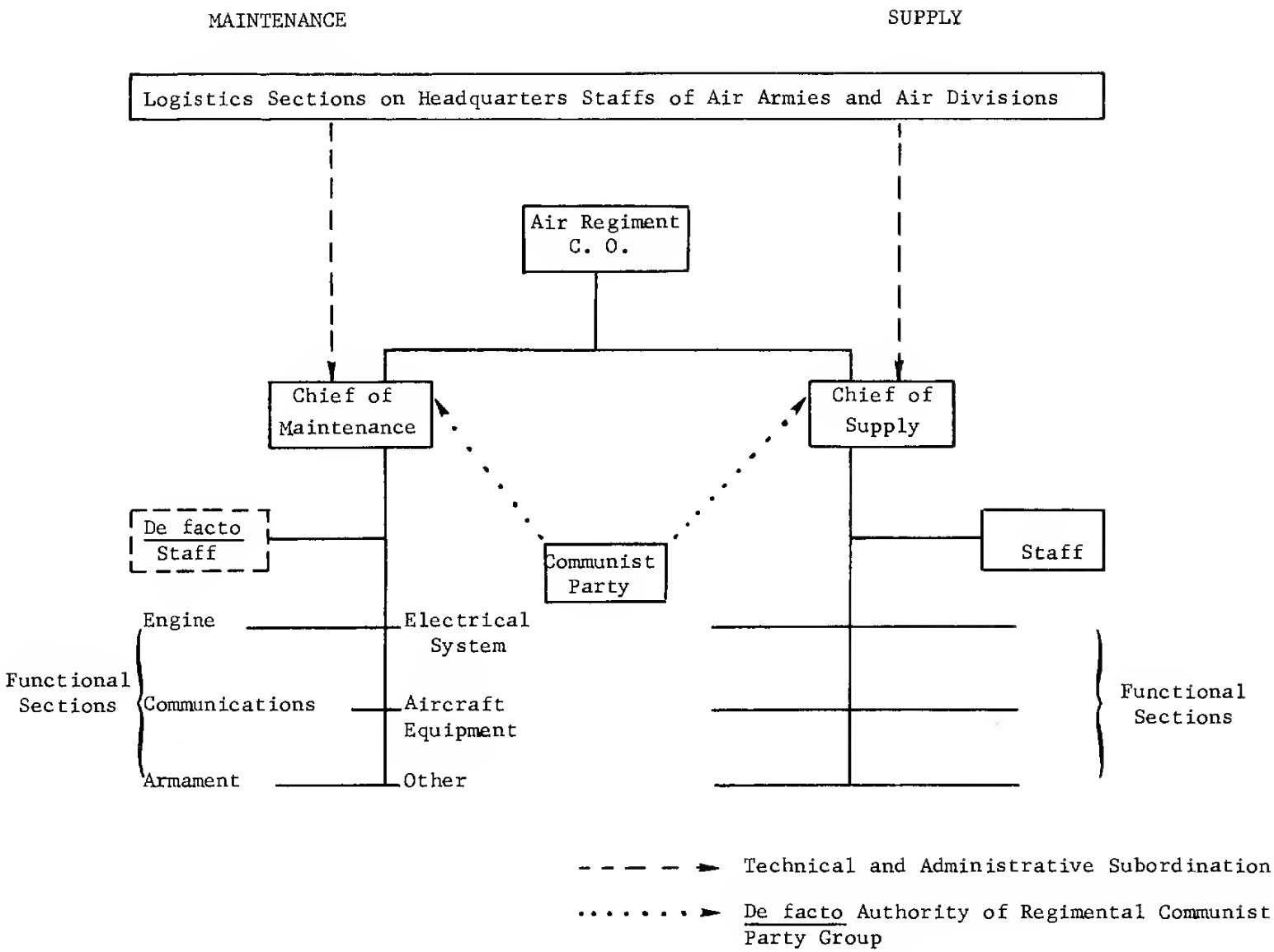
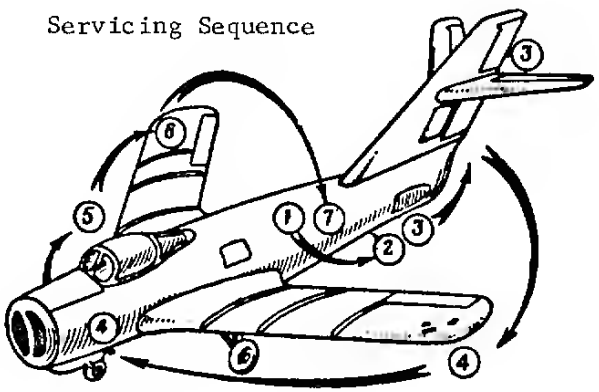


Fig. 1 -- Logistic Support Organization of Soviet Air Regiments

Servicing Sequence



Servicing time table

Objectives	1	2	3	4	5	6	7	Reserve Time
Time (minutes & seconds)	1'	20"	30"	2'50"				

COMMUNICATIONS MECHANIC'S ASSIGNED SEQUENCE OF OPERATIONS AND TIME TABLE

Description of objectives:

No. 1: Switch on power supply on command

No. 2: Check radar fastening

No. 3: etc.

No. 4: _____

No. 5: _____

No. 6: _____

No. 7: _____

"Approved by Chief of Maintenance" (signature)

Fig. 2 -- "Plan-Chart" Used by Mechanic in Preflight Inspections

(The "flow-line" approach requires detailed planning. Cards such as the above are issued to flightline maintenance personnel, showing the operations they are required to perform. Note the strict sequence of operations and the time standards for each in minutes and seconds.)